Fertility Transition in Sub-Saharan Africa: Falling and Stalling

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Abstract

This paper uses data from the Demographic and Health Surveys to examine the current status of fertility transition in sub-Saharan Africa, including the extent to which fertility decline has stalled. Among the two dozen countries covered by multiple surveys, 22 have initiated fertility transition, and a third of these countries have experienced stalling of fertility decline. We study the links between changes in contraceptive use, fertility preferences, and socioeconomic development (as reflected in changes in women's education, infant and child mortality, and real per-capita economic growth) and fertility decline and stalling. Changes in the measures of socioeconomic development are all related to the likelihood of stalling. We also analyze determinants of age-specific fertility rates in urban and rural places, and assess future prospects for fertility decline in the region. Progress in increasing women's educational attainment and in reducing infant and child mortality are identified as key factors contributing to sustained fertility decline.

Key words: fertility, stalling, education, infant/child mortality

Résumé

Cet article utilise les données issues des Enquêtes Démographiques et de Santé afin d'examiner l'état actuel de la transition de la fécondité en Afrique sub-saharienne, y compris le ralentissement ou l'interruption du processus de transition. Parmi les 24 pays couverts par au moins deux enquêtes, la baisse de la fécondité s'est amorcée dans 22 pays, mais ce processus s'est ensuite arrêtée dans un-tiers de ces pays. Nous étudions les liens entre les changements dans l'utilisation de la contraception moderne, les préférences en matière de fécondité, et le développement socio-économique (mesuré par l'accroissement de la scolarisation des femmes, la baisse de la mortalité infantile et juvénile, et la croissance du PNB brut réel par habitant) d'une part, et la baisse et la stabilisation de la fécondité, de l'autre part. Les résultats indiquent un lien entre chacun de ces indicateurs du développement socio-économique et la probabilité de voir une transition interrompue. Nous analysons également les déterminants des taux de fécondité par âge dans les milieux urbain et rural, et nous essayons d'évaluer les perspectives d'avenir de la baisse de la fécondité dans la région. L'augmentation de la scolarisation des femmes et la réduction de la mortalité infantile et juvénile apparaissent comme facteurs clefs pour une baisse soutenue de la fécondité.

Introduction

During the 1960s, 1970s, and 1980s, as fertility decline spread throughout much of the Third World, sub-Saharan Africa was distinguished as the only major region in the world without any indication of onset of fertility transition (Lesthaeghe, 1989a). A substantial literature emerged that discussed the various social, cultural, and economic factors that served to maintain fertility at high levels in Africa south of the Sahara.

By the early 1990s, however, it began to be apparent that change was taking place, and that fertility in at least a few African nations was beginning to fall. Over the past 15 years, several studies have documented, first, the spread of fertility transition throughout the region (Tabutin, 1997; Cohen, 1998; Tabutin and Schoumaker, 2001; Garenne and Joseph, 2002; Shapiro and Tambashe, 2002; Shapiro et al., 2003), and more recently, the stalling of the transition in some countries that had been at the forefront of fertility decline in sub-Saharan Africa (Bongaarts, 2005, 2007; Westoff and Cross, 2005).

This paper uses data from the numerous Demographic and Health Surveys that have been carried out in sub-Saharan Africa to examine the current status of fertility transition in the region, including the extent to which fertility decline has stalled; to study the links between changes in contraceptive use, fertility preferences, and socioeconomic development (as reflected in changes in women's education, infant and child mortality, and real per-capita economic growth) and fertility decline and stalling; to analyze determinants of age-specific fertility rates in urban and rural areas; and to assess future prospects for fertility decline in the region. We focus on survey results from the 24 countries that have had multiple Demographic and Health Surveys, since these data, representing more than three-quarters of the region's population, provide direct evidence on fertility transition within individual countries.

In his analysis of the causes of stalling fertility transitions, Bongaarts (2005, Table 1) provides an overview of national total fertility rates (TFRs) in recent DHS surveys in 38 countries, half of which are from sub-Saharan Africa. Among these 19 African countries, two are identified as stalled (Ghana and Kenya), 12 show a declining trend, and the remaining five cases are essentially considered as either pre-transitional or in the early stages of fertility transition. Bongaarts focuses on countries experiencing a stall in fertility in mid-transition, where stall is defined operationally as a failure of the national TFR to decline between the two most recent DHS surveys, and mid-transition refers to countries in which the TFR has fallen to at least 5 as of the most recent survey.

Our approach, with an expanded set of countries and results from several more recent surveys, is similar to that of Bongaarts in that we focus on changes in national TFRs between the two most recent DHS surveys in order to distinguish falling from stalling fertility. However, we also identify and analyze behavior in several countries that appear to be experiencing stalling in early stages of fertility transition. That is, we distinguish mid-transition stalls from early-transition stalls. In addition, reflecting our own previous work (Shapiro and Tambashe, 2002; Shapiro et al., 2003) as well as work by Garenne and Joseph (2002), we examine TFRs not only at the national level but also separately for urban and rural places. Indeed, not unlike elsewhere, fertility transition in sub-Saharan Africa is first manifested in urban places, prior to being evident in rural areas.

The first substantive part of the paper, then, consists of an up-to-date assessment of the fertility transition in sub-Saharan Africa. As noted, we focus on those countries that have been covered by multiple DHS surveys. In some of these countries (e.g., Kenya, Ghana, Cameroon) it is apparent from the most recent surveys that the declines in fertility that had been realized during the 1990s seem to have halted, and a certain stability in the overall level of fertility has emerged, at least for the time being. Whether these stalls will be temporary or longer-lasting remains to be seen.

In the second substantive section of the paper, we examine factors presumed to be contributing to fertility decline and fertility stall in sub-Saharan Africa. Among these African countries, do differences in contraceptive use or in fertility preferences help account for which countries are experiencing stalling? Bongaarts (2005, p. 2) noted that "[t]he stalls appear to be attributable at least in part to a lack of recent progress in socioeconomic development in Ghana and Kenya." In subsequent work, Bongaarts (2007, p. 13) has suggested that "lack of recent progress in development in sub-Saharan Africa is partly responsible for the very slow pace of reproductive change" that he documents based on analysis of TFRs in the most recent intervals between DHS surveys.

More broadly, as Bongaarts and Watkins (1996) and Bongaarts (2002) have noted, levels of socioeconomic development at which fertility decline is initiated appear to have declined over time. Sub-Saharan Africa's overall development level has been low, and countries in the region may consequently be especially susceptible to stalling of fertility decline. At the same time, however, there is certainly variation in the pace of development across countries. Within the African context, can differences in socioeconomic development help explain falling and stalling fertility? For example, has slowing of progress in augmenting women's educational attainment contributed to stalling of fertility transition? Likewise, following Bongaarts, we examine the impact of changes in infant and child mortality and changes in real GDP per capita on fertility decline. The relationships between fertility decline and these various factors are examined in a multivariate context.

The concluding substantive part of the paper presents multivariate regression analyses of the age-specific fertility rates of urban and rural women and of key proximate determinants of fertility. These analyses seek to identify factors contributing to differences in fertility levels and changes. Our earlier work on fertility transition in the region emphasized the importance of women's education in contributing to fertility decline, both directly and via the proximate determinants of marriage and contraceptive use, as well as via the influence of education on infant and child mortality. We explore the robustness of these conclusions in the face of new data including stalling experience, and with additional countries. The paper concludes with a discussion regarding the future of fertility transition in the region and policy implications of our findings.

Fertility Transition in Sub-Saharan Africa

An overview of fertility transition in sub-Saharan Africa is provided by the data in Table 1, which gives national total fertility rates as well as those for rural and urban places for each DHS survey[1] where there have been multiple DHS surveys. For each country, the table also identifies the trend in fertility, based on examination of the national TFR in the two most recent surveys.

As shown in Table 1, we find that stalling of fertility transition characterizes eight of the 24 countries, while 14 countries show a declining trend and the remaining two countries may be characterized as pre-transitional.[2] The eight countries identified as experiencing stalling include three that fit the mid-transition classification used by Bongaarts (Cameroon has been added to Ghana and Kenya), and five others that are at an earlier stage in their fertility transitions, with national TFRs in the neighborhood of 5.5 to 6 and no decline or an increase in the national TFR between the two most recent surveys (Guinea, Mozambique, Rwanda, Senegal, and Tanzania).[3] As compared to Bongaarts (2005), then, we point to a greater incidence of stalling, primarily because of the less restrictive definition of stalling that we have used to identify cases of early stalling.

At the same time, most countries continue to experience fertility decline. This is a heterogeneous group with respect

[1] *One exception here is the 1999 DHS for Nigeria. Concerns about data reliability prompted us to exclude results from that survey.*

[2] *The bulk of the data in Table 1 is from the STATcompiler available at the DHS web site. In several cases, though (as indicated in the table), the data were obtained from ORC/Macro published reports because they are not available on the STATcompiler. These include three quite recent surveys and three older surveys.*

[3] *That is, these five countries meet the first of the two criteria used by Bongaarts – viz., failure of the national TFR to decline between the two most recent surveys. Rwanda, Senegal, and Tanzania are identified in Table 1 of Bongaarts (2005) as countries experiencing fertility decline. The status or Rwanda and Tanzania has changed due to new survey data, while our inclusion of the 1999 Senegal DHS leads us to classify Senegal as stalled. From among these five countries, only Senegal and Tanzania show (via the DHS data) a decline of at least close to 10 percent in the national TFR. However, for each of these countries comparisons of United Nations estimates of national TFRs in the 1970s and 1980s with DHS estimates suggest that fertility decline of at least 10 percent had taken place prior to the emergence of stalling. Further, from the available DHS data it is apparent that at least in urban places, fertility had previously declined in Guinea and in Mozambique, as well as in Senegal and Tanzania.*

to fertility change, including both countries where the most recent declines in fertility have been substantial (e.g., Eritrea, Namibia, and Togo) as well as countries in which fertility at the national level has declined but rather modestly (e.g., Chad, Cote d'Ivoire, and Ethiopia). Finally, the pre-transitional countries (Mali and Niger) are those in which the national TFR is on the order of 7, and where there has been little or no decline across surveys. Figure 1 shows the 8 stalling countries and the 14 declining nations, ordered by the size of the decline per year in the TFR between the two most recent surveys.[4]

As in previous work on fertility transition in the region (Shapiro and Tambashe, 2002; Shapiro et al., 2003), we also examine data for urban and rural places separately. In our earlier studies we noted that initially fertility tended to fall primarily in urban places, while rural fertility remained stable or increased. Garenne and Joseph (2002) also emphasize the key role of urban places in the onset of fertility transition in the region. Our earlier research suggested that subsequent to the initial drop in fertility limited to urban areas, fertility declined in both urban and rural places, but typically the decline was greater in the urban milieu. And finally, in the few countries in the region in which fertility transition was relatively advanced, fertility fell as rapidly or more so in rural areas as compared to urban areas.

These observations were made prior to the emergence of stalling. Table 1 allows examination of the extent of stalling separately for urban and rural places. Among the mid-transition stalled countries (Cameroon, Ghana, Kenya), in which overall fertility is relatively low, we see increases in both rural and urban fertility most recently. That is, stalling is pervasive in these countries, regardless of place of residence. The early-transition stalled countries, by contrast, show greater variability, at least for urban places. These countries, which all have their most recent national TFRs above 5 and rural TFRs above 6, typically have reported increases recently in rural fertility, while there is no clear pattern vis-à-vis changes in urban fertility, with declines reported in two cases, an increase in two others, and stability in the fifth case. Countries that nationally show only small declines in the TFR often have stalled rural fertility in conjunction with urban fertility that is still declining.

In sum, then, the data in Table 1 highlight several observations regarding fertility transition in sub-Saharan Africa, based on data at the national level from 24 countries with multiple DHS surveys. First, with the exception of only a couple of countries, it is evident that fertility transition has been initiated throughout the region. Second, the majority of the countries in which fertility decline has

[4] We have categorized countries as stalling or declining based on Bongaarts (2005). In subsequent work, Bongaarts (2007) has used a more stringent criterion for fertility decline: failure to experience "a significant fertility decline between the two most recent surveys" (p. 12). This more stringent criterion for decline implies a less restrictive definition of stalling. For example, had we required a decline in the national TFR of at least 0.2 in order to identify a country as declining, we would have reported 11 stalling countries and 11 countries in which fertility is still declining.

begun continue to experience decline, albeit with a fair degree of variability in the pace of that reduction. Third, countries in which fertility transition has stalled (the national TFR has failed to continue its previous decline) may be divided into two groups: those in which the prior fertility decline had brought the national TFR to 5 or less (mid-transition stall) and those in which the prior decline in fertility was more modest and the national TFR was approximately 5.5 to 6 (early-transition stall).

Further, disaggregation of national data into urban and rural components indicates that fertility decline tends to be stronger in urban places. Among those countries with a declining trend in fertility, it is typically the case that in comparing the two most recent surveys the magnitude of the decline is greater in urban areas than in rural areas (in only four of 14 cases does the rural decline exceed the urban decline). And countries experiencing stalling nationally, at least at the early-transition stage, in some cases still experience fertility decline in urban areas. We turn now to an examination of factors contributing to observed fertility behavior.

Table 1. Estimated Total Fertility Rates, National and by Rural and Urban Residence, and Trend: Countries with Multiple Surveys

Country (year of survey)	TFR			Trend
	National	Rural	Urban	
Benin (1996)	6.0	6.7	4.9	
Benin (2001)	5.6	6.4	4.4	decline
Burkina Faso (1992/93)*	6.9	7.3	5.0	
Burkina Faso (1998/99)	6.4	6.9	3.9	
Burkina Faso (2003)	5.9	6.5	3.4	decline
Cameroon (1991)	5.8	6.3	5.2	
Cameroon (1998)	4.8	5.4	3.8	
Cameroon (2004)	5.0	6.1	4.0	mid-transition stall
Chad (1996/97)	6.4	6.5	5.9	
Chad (2004)	6.3	6.5	5.7	decline
Cote d'Ivoire (1994)	5.3	6.0	4.4	
Cote d'Ivoire (1998/99)	5.2	6.0	4.0	decline
Eritrea (1995)	6.1	7.0	4.2	
Eritrea (2002)	4.8	5.7	3.5	decline
Ethiopia (2000)	5.5	6.0	3.0	
Ethiopia (2005)	5.4	6.0	2.4	decline
Ghana (1988)	6.4	7.0	5.3	
Ghana (1993)	5.2	6.0	3.7	

Country (year of survey)	TFR			Trend
	National	Rural	Urban	
Ghana (1998)	4.4	5.3	3.0	
Ghana (2003)	4.4	5.6	3.1	mid-transition stall
Guinea (1992)*	5.7	5.9	5.2	
Guinea (1999)	5.5	6.1	4.4	
Guinea (2005)	5.7	6.3	4.4	early-transition stall
Kenya (1989)	6.7	7.1	4.5	
Kenya (1993)	5.4	5.8	3.4	
Kenya (1998)	4.7	5.2	3.1	
Kenya (2003)	4.9	5.4	3.3	mid-transition stall
Madagascar (1992)	6.1	6.7	3.8	
Madagascar (1997)	6.0	6.7	4.2	
Madagascar (2003/04)	5.2	5.7	3.7	decline
Malawi (1992)	6.7	6.9	5.5	
Malawi (2000)	6.3	6.7	4.5	
Malawi (2004)	6.0	6.4	4.2	decline
Mali (1987)	7.1	7.4	6.3	
Mali (1995/96)	6.7	7.3	5.4	
Mali (2001)	6.8	7.3	5.5	pre-transition
Mozambique (1997)	5.2	5.3	4.6	
Mozambique (2003)	5.5	6.1	4.4	early-transition stall
Namibia (1992)	5.4	6.3	4.0	
Namibia (2000)	4.2	5.1	3.1	decline
Niger (1992)	7.0	7.1	6.4	
Niger (1998)	7.2	7.6	5.6	
Niger (2006)*	7.1	7.4	6.0	pre-transition
Nigeria (1990)	6.0	6.3	5.0	
Nigeria (2003)	5.7	6.1	4.9	decline
Rwanda (1992)	6.2	6.3	4.5	
Rwanda (2000)	5.8	5.9	5.2	
Rwanda (2005)	6.1	6.3	4.9	early-transition stall
Senegal (1986)	6.4	7.1	5.4	
Senegal (1992/93)	6.0	6.7	5.1	
Senegal (1997)	5.7	6.7	4.3	
Senegal (1999)*	5.2	6.1	3.9	
Senegal (2005)	5.3	6.4	4.1	early-transition stall

Country (year of survey)	TFR			Trend
	National	Rural	Urban	
Tanzania (1992)	6.2	6.6	5.1	
Tanzania (1996)	5.8	6.3	4.1	
Tanzania (1999)	5.6	6.5	3.2	
Tanzania (2004)	5.7	6.5	3.6	early-transition stall
Togo (1988)	6.4	7.3	4.9	
Togo (1998)	5.2	6.3	3.2	decline
Uganda (1988)	7.4	7.6	5.7	
Uganda (1995)	6.9	7.2	5.0	
Uganda (2000/01)	6.9	7.4	4.0	
Uganda (2006)*	6.7	7.1	4.4	decline
Zambia (1992)	6.5	7.1	5.8	
Zambia (1996)	6.1	6.9	5.1	
Zambia (2001/02)	5.9	6.9	4.3	decline
Zimbabwe (1988/89)	5.4	6.2	3.8	
Zimbabwe (1994)	4.3	4.9	3.1	
Zimbabwe (1999)	4.0	4.6	3.0	
Zimbabwe (2005/06)*	3.8	4.6	2.6	decline

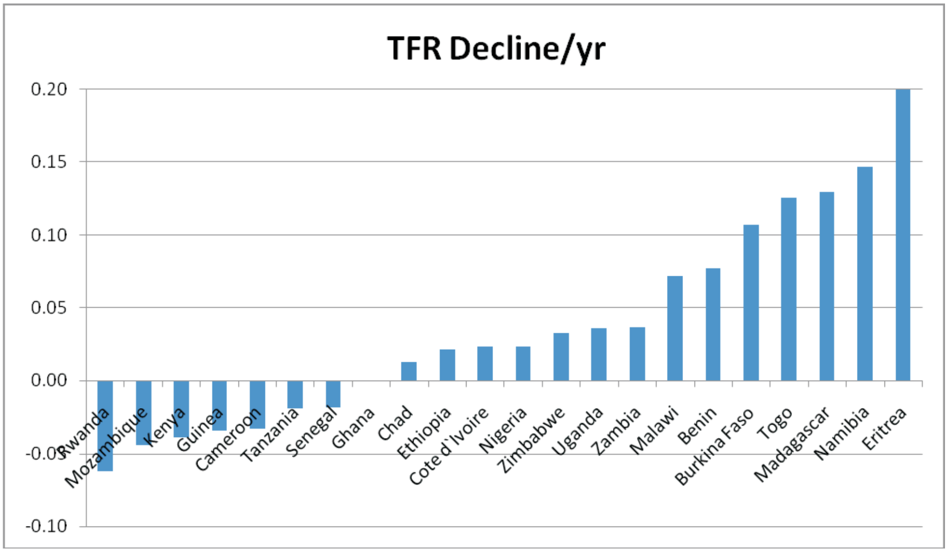
Except as noted, data are from ORC Macro's online StatCompiler, and provide TFRs based on the three years preceding each survey.
[*] Estimates obtained from DHS Final Report

Factors Contributing to Fertility Decline and Fertility Stall

In this section we examine several factors that, based on both models of fertility behavior and empirical studies of fertility and fertility transition, seem likely to be pertinent to the falling and stalling of fertility. More specifically, we look at changes in these factors between the next-to-last and the most recent DHS survey in each country, and relate those changes to the corresponding changes in the national total fertility rate.

We begin with consideration of the link between changes in the educational attainment of women of reproductive age and changes in the TFR. A considerable body of research underscores the general inverse association between education and fertility (see, for example, Jejeebhoy, 1995; Rutstein, 2002), and our own prior work (Shapiro et al., 2003; Shapiro and Tambashe, 2003) emphasizes the importance of women's education as a key factor contributing to fertility decline in sub-Saharan Africa. Since the secular trend is toward increased education of women (Schultz, 1993), this implies increases over time in the percentage of women with secondary or higher education and reductions in the percentage of women with no schooling.

Fig. 1. Decline in the Total Fertility Rate per Year, Stalling and Declining Countries



We anticipated that countries with relatively large increases in the share of women with at least some secondary schooling would exhibit larger declines in fertility as compared to countries with smaller increases or with decreases in the proportion of women with secondary or higher education. By the same token, countries with relatively large declines in the percentage of women with no schooling were expected to manifest larger declines in fertility.

A second factor pertinent to fertility behavior is mortality experience. The Easterlin framework for fertility analysis (Easterlin, 1975; Easterlin and Crimmins, 1985) views changes in mortality as a key factor influencing actual fertility, via the impact on the supply of children and ultimately on the motivation for fertility control. Indeed, observed increases in mortality in DHS surveys in West Africa during the late 1990s (Barrère et al., 1999), in the context of Easterlin's model, would be the sort of phenomenon likely to contribute to stalling of fertility transition. In our initial exploratory work we found that lagged changes[6] in mortality were more closely related to fertility changes than were contemporaneous mortality changes. Further, the infant and child mortality rate appeared to perform better than the infant mortality rate. Hence, in the analyses below we used the infant and

[5] *Data are from the Penn World Tables (Heston et al., 2006). Since fertility is measured for the three years preceding the survey, this lag means that we are looking at the change in GDP per capita for roughly the five-year period preceding the period during which fertility is measured.*

[6] *In an early version of the equation in the table, ideal family size had a coefficient that was essentially zero, and the variable has been dropped from our analyses.*

child mortality rate, lagged 5-9 years.

We also examine growth in GDP per capita in relation to fertility decline. Historically, fertility transition was generally accompanied by sustained economic growth. At the same time, however, there is some literature suggesting that economic difficulties experienced by countries in sub-Saharan Africa during the 1980s and 1990s may have contributed to crisis-led fertility declines (e.g., see Lesthaeghe, 1989b; Eloundou-Enyegue et al., 2000; National Research Council, 1993). In the analyses reported below, we use lagged estimates of growth in real GDP per capita for the period from three to eight years prior to the most recent survey.

Increased use of modern contraception is typically strongly associated with fertility decline, so we examine changes in use of modern contraception and their relation to fertility changes. Finally, we also looked at changes in fertility preferences (ideal family size) in relation to changes in observed fertility.[7]

We estimated a multivariate equation to account for these most recent changes in national-level fertility, using all of the variables just considered except ideal family size. This equation is reported in the first column of coefficients in Table 2. More rapid growth in female educational attainment, as reflected both by greater increases in the percentage of women of reproductive age with at least secondary education and by larger declines in the percentage of women with no schooling, is significantly associated with larger declines in fertility. Greater declines in the lagged infant and child mortality rate are significantly associated with more rapid fertility decline. For these variables, then, the implication is that slower socioeconomic progress contributes to the stalling of fertility transition. At the same time, however, and in contrast, more rapid (lagged) growth in GDP per capita translates into significantly slower declines in fertility, other things equal. On this count, then, economic growth appears to be contributing to stalling fertility. Changes in the use of modern contraception are not related to recent changes in fertility. Overall, these variables account for more than 60 percent of the variation in the declines in the total fertility rate between the two most recent surveys.

The second column of Table 2 extends the analysis, with data now reported separately for urban and rural places, so the number of observations has doubled. In addition, a dummy variable for urban areas is included. This second set of estimates is quite similar to the first.

[7] *In analyzing data by place of residence, we were unable to use data from the most recent surveys in Niger and Uganda, since the data are not yet available. Hence, for these two countries we had to use earlier data. In addition, for urban and rural places, the STATcompiler does not provide mortality estimates for the period 5-9 years prior to the survey, but rather for the period 0-9 years prior to the survey. To check for the robustness of our results, we reestimated the first equation in Table 2 using the same surveys as those in the second equation. The estimated coefficients were very similar to those reported in the table, both in magnitude and in significance, with the exception of the mortality coefficient, which remained highly significant but was twice as large as that reported in the table (i.e., it was closer to the coefficient reported in the second column of the table).*

Table 2. Regression Analysis of the Decline in the Total Fertility Rate Between the Two Most Recent Survey

Variable	National Data	Data by urban/rural
Decline in percentage of women with no schooling	.036+	.039*
Increase in percentage of women with at least secondary education	.031+	.018
Growth in the percentage of women using modern contraception	.006	.011
Decline in the infant and child mortality rate[a]	.0048*	.0081**
Percentage growth in GDP per capita over 5 years (3-year lag)	-.010**	-.0098**
Urban	---	.191+
Intercept	-.041	-.104
R^2	.618	.572
$\bar{R}^2$	.512	.509
F-Ratio	5.83**	9.13**
N	24	48

[a] For national-level data, we use the infant and child mortality rate for the period 5-9 years prior to the survey; for data separately for urban and rural places, we use the infant and child mortality rate for the period 0-9 years prior to the survey.

** Significant at the .01 level.
* Significant at the .05 level.
+ Significant at the .10 level.

Both of the education variables have the expected sign, although only one coefficient is significant. Declining mortality is significantly associated with more rapid fertility decline, while more rapid GDP growth appears to result in slower fertility declines. And other thing equal, fertility decline tends to be more rapid in urban areas. These results, then, indicate that falling and stalling fertility are very much influenced by socioeconomic development, most notably as reflected in women's education, infant and child mortality, and growth in GDP per capita.[8]

[8] *These estimates parallel our earlier ones (Shapiro et al., 2003), but cover a larger number of countries (we analyzed data for 16 countries previously) and include more recent data, most notably data that reveals stalling.*

Multivariate Analyses of Age-Specific Fertility Rates

In this section, we extend our analyses to examine age-specific fertility rates in urban and rural areas of the DHS countries with multiple surveys. More specifically, we analyze the factors[9] influencing age-specific fertility rates by estimating a series of regressions comparable to those estimated in our previous work (Shapiro et al., 2003). In each case, we use data from the two most recent DHS surveys.

For each five-year age group, we regress the age-specific fertility rates of women in urban and rural areas on variables measuring the percentage of women in the age group and corresponding place of residence who had no schooling, the percentage with secondary or higher education, the percentage in union, the percentage of women in union using modern contraception, the infant and child mortality rate (5q0), and a dummy variable distinguishing urban from rural areas. In addition, in light of the finding by Bongaarts and Watkins (1996) and Bongaarts (2002) that as time goes by, fertility decline occurs at progressively lower levels of socioeconomic development, we also include a variable identifying a time trend.

For these analyses of age-specific fertility, it is plausible to anticipate that the error terms for different age groups may be correlated. That is, in countries where fertility of one age group is comparatively high or low, given the values of the explanatory variables, it is likely that fertility of other age groups may correspondingly be high or low as well. Correlations like this would emerge in the presence of country-specific factors whose influence cut across various age groups, and we found such correlations in our previous work. Under these circumstances, the appropriate estimation is via the method of seemingly unrelated regressions (SUR) rather than via OLS (Greene, 2000, pp. 614 ff.). Consequently, the estimates reported below are SUR estimates.

In considering the likely impacts of the explanatory variables, we anticipated that the percentage of women with no schooling, the percentage in union, and the infant and child mortality rate would all be positively related to age-specific fertility rates, while the percentage with secondary and higher education and the percentage of women in union who were using modern contraception were expected to be negatively related to fertility. The dummy variable for urban residence was expected to have a negative coefficient, reflecting the lower net benefits of children to parents in urban places. We anticipated as well that other things equal, fertility rates would be

[9] *In contrast to the other variables just identified (apart from the urban dummy), the infant and child mortality rate was not calculated separately for each age group; rather, it was simply the urban or rural rate across all age groups of mothers. Initially we also included a variable measuring GDP growth. Since GDP growth is not available separately by place of residence, this variable was measured at the national level, and hence the same value was used for both urban and rural places. The variable was almost always not significant, and its use meant dropping Eritrea from the sample because of lack of data on GDP growth for the earlier survey. Hence, we have dropped GDP growth so as to retain the full set of 24 countries.*

lower in later years (i.e., the expected coefficients for the time trend are negative).
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The results of our analyses are reported in Table 3. For each age group, we give the coefficients for the regression described above. Other things being equal, fertility is significantly lower in urban places, with the differential being greater than 40 births per 1000 for women in their 20s, 30-36 for those aged 30-44, and somewhat smaller for the youngest and oldest women. The coefficients for the two education variables provide little indication of the expected positive effect on fertility of higher percentages of women with no schooling or the anticipated negative effect of women with secondary or greater education.

Between ages 25 and 44 there is a significant negative association between modern contraceptive use and fertility, while there is an unexpected positive coefficient for contraception for the youngest group. The percentage of women in union is significantly positively related to fertility for all but one group up through the 35-39 age group, with the significant coefficients declining as age increases. Higher infant and child mortality rates are associated with significantly higher age-specific fertility rates between ages 20 and 34. There are significant negative coefficients on the time trend variable for all but one group, indicating that, other things equal, fertility rates are[10] lower in later years as compared to earlier years.

Table 3. Multivariate Analyses of Age-Specific Fertility Rates

Age Group	Urban	Schooling: None	Schooling: Secondary+	Modern Contraception	In Union	$_5q_0$	Time Trend	Intercept	$\bar{R}^2$
15-19	-25.21**	-.12	.10	1.39**	2.47**	.10	-1.49*	70.5**	.734
20-24	-43.62**	-.28*	.00	.13	1.70**	.25**	-1.68*	142.34**	.713
25-29	-41.51**	-.14	.31*	-.78**	.91**	.31**	-1.33+	168.23**	.644
30-34	-36.16**	.11	.20	-1.32**	.13	.22*	-.11	198.01**	.523
35-39	-36.06**	.14	-.14	-.66**	.66*	.05	-1.33+	129.90**	.590
40-44	-30.61**	.02	-.15	-.69**	-.18	.01	-1.37**	131.30**	.612
45-49	-17.57**	.19**	-.01	.09	.01	-.05	-1.01**	43.03**	.425

** Significant at the .01 level.
* Significant at the .05 level.
+ Significant at the .10 level.
Sample size = 96. Estimates from SUR model.

[10] *We are grateful to Paul Schultz for drawing our attention to this point.*

The near absence of significant effects of women's educational attainment on fertility at first glance seems somewhat surprising. However, the equations reported in Table 3 include two proximate determinants of fertility, use of modern contraception and the percentage in union, that are themselves influenced by women's educational attainment. Further, there is a large body of literature suggesting that increased women's schooling contributes to lower infant and child mortality. By including in Table 3 these variables that are themselves influenced by education, we may have thereby given a misleading (and downward-biased) view of the importance of education for fertility transition in the region.

To assess this argument, then, we have estimated equations showing the relationship between women's educational attainment and these three education-related explanatory variables (contraception, in union, mortality) from Table 3. That is, we regressed the prevalence of modern contraception, the percentage of women in union, and the infant and child mortality rate on the two dummy variables for educational attainment, and we also included the urban dummy variable and the time trend as explanatory variables in these equations. As in Table 3, we used the method of seemingly unrelated regressions[11]. The results of this estimation are provided in Table 4.

[11] *The fact that infant and child mortality rates are not measured separately for the different age groups may contribute to the weak performance of the secondary-plus schooling variable in accounting for differences in infant and child mortality.*

The influence of women's educational attainment on these variables is evident, especially so for use of modern contraception and being in union. Higher percentages of women with no schooling result in lower contraceptive use, greater marriage rates, and, among the two youngest age groups only, higher levels of infant and child mortality. Conversely, greater percentages of women with secondary or higher education are clearly associated with greater contraceptive use and with lower percentages in union among women up through age 39, but there is no evidence of significantly lower infant and child mortality rates. Overall, then, it is evident that education influences these three variables: other things equal, a better-educated population of women of reproductive age is associated with greater use of modern contraception, lower rates of women in union, and to a lesser degree, lower infant and child mortality.

Urban residence is significantly associated with greater use of modern contraception, lower percentages of women who are married (especially in the two youngest age groups), and substantially lower infant and child mortality rates, net of education and other factors. Net of the effects of education and urban residence, there is a significant time trend indicating increased use of modern contraception over time among women in all age groups, and likewise infant and child mortality decline significantly as time goes by, holding constant the effects of other factors. There is no significant time trend with respect to the percentage of women in union.

Table 4. Educational Attainment and Contraception, Marriage, and Mortality

a. Percentage using modern contraceptives

		Percentage with				
Age group	Urban	No Education	Secondary+	Time Trend	Intercept	$\overline{R}^2$
15-19	2.7*	-.00	.05*	.20+	.67	.239
20-24	6.06**	-.07**	.05*	.70**	2.84	.381
25-29	7.25**	-.06*	.11**	.89**	2.31	.404
30-34	7.56**	-.07**	.11**	.83**	3.91	.421
35-39	8.00**	-.12**	.06+	.68**	9.42**	.456
40-44	6.92**	-.09**	.10**	.54*	8.49*	.448
45-49	3.68*	-.06**	.11**	.34*	6.28*	.377

b. Percentage in union

		Percentage with				
Age group	Urban	No Education	Secondary+	Time Trend	Intercept	$\overline{R}^2$
15-19	-8.83**	.20**	-.08+	-.32	31.5**	.498
20-24	-14.84**	.13**	-.10*	-.29	73.65**	.517
25-29	-5.87**	.09**	-.14**	-.07	83.03**	.481
30-34	-3.41*	.07**	-.10**	-.14	85.72**	.453
35-39	-3.03+	.08**	-.09*	-.24	85.21**	.362
40-44	-4.89**	.08**	-.02	-.23	81.19**	.302
45-49	-6.11**	.06+	-.05	-.39+	80.46**	.265

c. Infant and Child Mortality[1]

Age group	Urban	Percentage with No Education	Percentage with Secondary+	Time Trend	Intercept	$\bar{R}^2$
15-19	-42.22**	.18**	-.07	-2.74**	203.75**	.336
20-24	-43.77**	.11*	-.05	-2.83**	207.84**	.310
25-29	-43.91**	.08	-.08	-2.83**	207.84**	.302
30-34	-44.08**	.07	-.09	-2.80**	207.76**	.300
35-39	-44.14**	.10	-.06	-2.78**	204.99**	.303
40-44	-44.46**	.08	-.08	-2.75**	205.15**	.296
45-49	-45.31**	.09	-.06	-2.77**	204.17**	.292

** Significant at the .01 level.
* Significant at the .05 level.
+ Significant at the .10 level.
Sample size = 96. Estimates from SUR model.

[1]Mortality is not measured separately by age group, but simply separately by place of residence.

The final step in these multivariate analyses is given by Table 5, which provides reduced-form estimates that more clearly emphasize the importance of educational attainment, or perhaps more accurately, the importance of exposure to schooling, for fertility and fertility transition in sub-Saharan Africa. These equations omit modern contraceptive prevalence, percentage married, and infant and child mortality, and simply examine age-specific fertility rates as a function of educational attainment, urban residence, and the time trend. Comparison of coefficients in Table 5 with those in Table 3 shows the effects of omitting contraception, marriage, and mortality from the equation.

The coefficients on the first education variable indicate that higher percentages of women with no schooling are consistently associated with greater age-specific fertility rates, and in four cases the coefficients are significant. This contrasts sharply with the anomalous negative coefficients for the three youngest groups of women reported in Table 3. Greater percentages of women with secondary or higher education are associated with lower fertility rates for all but the oldest women, but with one exception the differences are not statistically significant. Urban-rural fertility differences, other things equal, are highly significant and consistently larger than those reported in Table 3, especially for the women under age 40. The coefficients of the time trend variables are all negative and significant. As with the urban variable, the coefficients of the time trend variable are larger in absolute value than those reported in Table 3, reflecting the correlations with time and urban residence of contraception, marriage, and mortality.

Table 5. Reduced-Form Estimates of the Impact of Education, Urban Residence, and Time on Age-Specific Fertility Rates

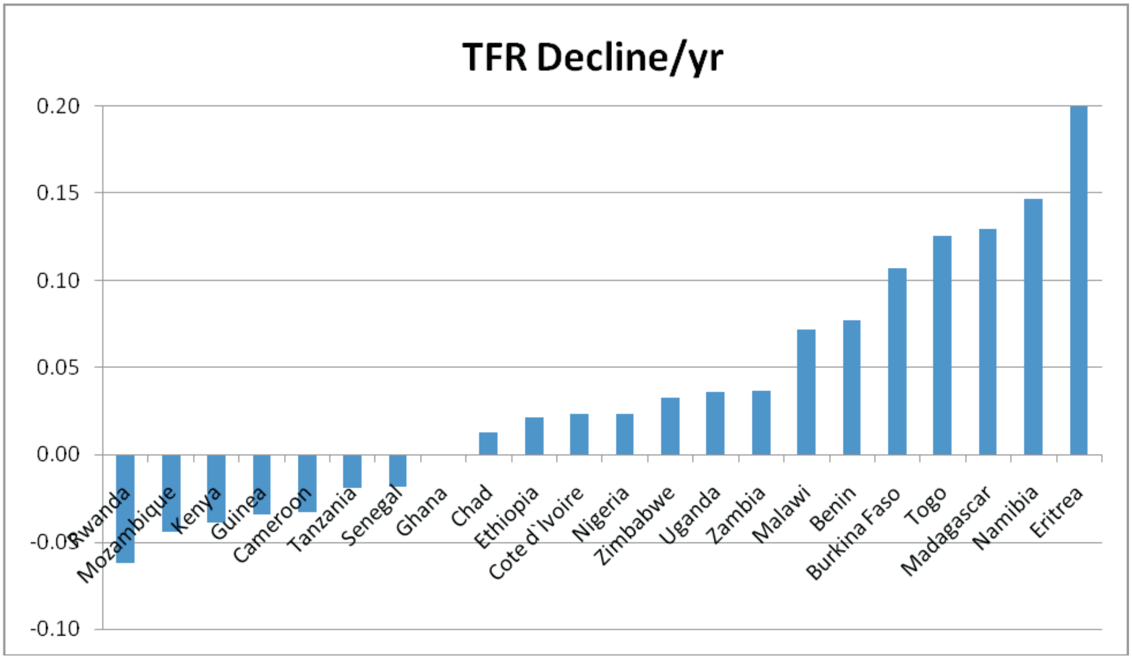
		Percentage with				
Age group	Urban	No Education	Secondary+	Time Trend	Intercept	$\bar{R}^2$
15-19	-44.23**	.51**	-.06	-2.15**	163.46*	.447
20-24	-73.42**	.17	-.18	-2.60**	307.07**	.556
25-29	-58.66**	.20	-.03	-2.74**	296.17**	.504
30-34	-51.91**	.29*	-.10	-1.70+	246.40**	.407
35-39	-46.35**	.28**	-.21	-2.12**	190.27**	.550
40-44	-35.63**	.04	-.22+	-1.76**	115.20**	.556
45-49	-17.54**	.13*	.03	-1.02**	37.79**	.410

** Significant at the .01 level.
* Significant at the .05 level.
+ Significant at the .10 level.
Sample size = 96. Estimates from SUR model.

Discussion and Conclusions

Using data for countries with multiple DHS surveys, we have examined fertility behavior in two dozen countries in sub-Saharan Africa, representing about three-quarters of the population of the region. Nearly all of these countries have experienced the onset of fertility transition, and in about 65 percent of the countries in which transition has begun the most recent DHS surveys suggest that fertility decline is still under way. However, the pace of decline is slow in several of these countries, and stalling of fertility decline is evident in the remaining countries where fertility decline had begun, with some of the stalling countries being in mid-transition while others are still in an early stage of fertility transition.

Fig. 1. Decline in the Total Fertility Rate per Year, Stalling and Declining Countries



Examination of national-level changes in fertility in relation to changes in variables presumed to be related to fertility found significant associations for two schooling variables, the lagged infant and child mortality rate (5q0), and for lagged growth in GDP per capita. The first two of these findings suggest, as Bongaarts (2005) has postulated, that stalling of fertility decline may reflect faltering in the pace of socioeconomic development. At the same time, the results indicating that higher growth in GDP per capita was associated with smaller declines in fertility run counter to this notion. Further, we did not find evidence of any significant relationships between changes in fertility and changes in modern contraceptive use or ideal fertility.

Disaggregation of national-level data to urban and rural components reveals additional differences, with fertility transition typically being distinctly stronger in urban areas. Our multivariate analyses of age-specific fertility rates document that education, infant and child mortality, modern contraceptive use, the percentage of women in union, place of residence, and time all are significantly related to fertility levels, and hence presumably influence changes in fertility as well. We put particular emphasis on increasing education as a key factor in promoting fertility decline, in large part because of its association with marriage, contraceptive use, and infant and child mortality.

What is the future of fertility transition in the region? Our data analyses suggest that in part, the answer will depend on the future of changes in education and in infant and child mortality. If the longer-term improvements in these socioeconomic indicators that have been realized in the past do not continue throughout the region (i.e., with stagnation or backsliding), then the stalling phenomenon may well spread to additional countries. Conversely, stronger progress in increasing women's education and reducing infant and child mortality in the future would be expected to enhance the likelihood of resumption of fertility decline in the stalling countries.

But even with resumption of fertility decline, however, the question remains, how far might fertility fall? As Bongaarts (2002) has noted, it is not at all apparent that assuming that fertility will fall to the replacement level (as in United Nations fertility projections) is the appropriate assumption. Indeed, in what may well have been a very prescient observation, Lesthaeghe (1989b) almost 20 years ago raised the possibility that fertility decline in sub-Saharan Africa might stall at high levels (4-5 children), reflecting the old-age security function of children. This raises the possibility that even sustained or resumed socioeconomic development, in the absence of alternative mechanisms for old-age security, would not be sufficient to prevent stalling on a wider basis.

In the meantime, however, the policy implications are clear. Countries that seek to avoid stalling and to maintain or accelerate fertility decline should pursue policies and programmes aiming to realize increased schooling for women and reduced infant and child mortality.

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